BRACKET FOR A FRAME

FIELD OF INVENTION

This invention relates to a bracket for engaging one or more struts and a method of engaging a bracket and strut. The invention also relates to a frame made from a plurality of brackets and struts and to the construction of a frame using the brackets and struts.

Although the following description refers almost exclusively to a frame for supporting services in buildings, such as gas pipes, water pipes, duct work, electrical cables and/or the like, it will be appreciated by persons skilled in the art the frame can be used in any application to support any article.

BACKGROUND TO THE INVENTION

Frames for supporting building service systems typically comprise a plurality of struts bolted and/or welded together to form a frame structure. The struts have either a generally U-shaped cross-sectional profile as depicted in Figure 1 or a generally C-shaped cross-sectional profile as depicted in Figure 2. Figure 1 depicts a conventional U-shaped strut from the UNISTRUT System. This strut is essentially a U-shaped channel member comprising a base (A), sidewalls (B) and lips (C). The lips extend into the interior of the channel member in a generally downwardly direction towards the base such that a U-shaped channel portion (D) is defined by each lip and the respective sidewall. The conventional C-shaped channel member depicted in Figure 2 also comprises a base (A'), sidewalls (B') and lips (C'). However, in this particular strut, the lips extend into the interior of the channel member in a substantially horizontal direction towards the opposing sidewall such that a U-shaped channel portion (D') is defined by each lip, sidewall and base and the strut has a C-shaped profile. The struts are usually formed from steel, particularly cold rolled steel. Prior to use, the struts are galvanised by hot dipping them in a suitable material to form a rust proof surface.

A frame is conventionally constructed by cutting the struts to the required length, connecting the struts together using spring nuts and bolts and welding the struts to further secure them. The use of nuts and bolts undesirably increases the number of components within the frame system, increases the complexity of construction and requires a specialist fitter and tools. Unfortunately, the welding process burns off the

galvanised surface of the struts and so the frame must be galvanised after construction to ensure it has a rust proof and aesthetically pleasing surface. Furthermore, the reject rate is high because the galvanising process distorts the frame. Hence, the conventional method of constructing and galvanising the frame is slow, complicated, inefficient, inaccurate and expensive. Frame manufacturers are therefore typically restricted to making and storing standard sized frames and they are unable to construct special order frames quickly, efficiently and cheaply.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided a bracket for engaging one or more struts comprising a body portion and one or more arm portions extending from the body portion, wherein the arm portions include:

at least one pair of parallel grooves adapted to releaseably engage complementary lips of the strut; and

at least one recessed region adapted to securely engage one or more crimped portions of the strut.

In one embodiment of this aspect of the invention, the respective grooves and at least one recessed region are arranged to co-operate with a strut in the form of a U-shaped channel member comprising a base, opposing sidewalls and lips extending from each sidewall into the interior of the channel member towards the base such that a U-shaped channel portion is defined by each lip and sidewall.

In another embodiment of this aspect of the invention, the respective grooves and at least one recessed region are arranged to co-operate with a strut in the form of a C-shaped channel member comprising a base, opposing sidewalls and lips extending from each sidewall into the interior of the channel member towards the opposing sidewall such that a U-shaped channel portion is defined by each lip, sidewall and the base.

Preferably the body portion comprises an upper face, lower face and side faces. In a preferred arrangement the one or more arm portions extend perpendicularly from the side faces of the body portion.

In various embodiments of this aspect of the invention, the bracket may be:

I-shaped comprising two arm portions extending perpendicularly from two opposing side faces of the body portion;

L-shaped comprising two arm portions extending perpendicularly from two adjacent side faces of the body portion;

T-shaped comprising three arm portions extending perpendicularly from three side faces of the body portion; or

cross-shaped comprising four arm portions extending perpendicularly from four side faces of the body portion.

In other preferred embodiments of the invention an arm portion extends perpendicularly from the upper face and/or lower face of the body portion.

Preferably in one variation of this aspect of the invention, the one or more arm portions comprise an upper face, lower face, opposing end faces and opposing side faces.

Preferably in this variation two grooves extend longitudinally in parallel alignment along the upper face of the one or more arm portions. Preferably the two grooves extend longitudinally in parallel alignment along the lower face of the one or more arm portions.

Preferably first and second grooves are arranged to extend longitudinally in parallel alignment along respective opposing side faces of the one or more arm portions.

Preferably each groove defines one or more protruding portions that extend longitudinally along the respective faces of the arm portions and which grooves are adapted to be received and engaged by the U-shaped channel portions of the lips. In this case preferably the protruding portions of the one or more arm portions comprise one or more recessed regions to receive and securely engage one or more crimped portions of the lips.

The upper face of the one or more arm portion may preferably comprise one or more recessed regions to receive and securely engage one or more crimped portions of the base of the strut.

In another preferred embodiment, the lower face of the one or more arm portions comprises one or more recessed regions to receive and securely engage one or more crimped portions of the base of the strut.

In a further preferred embodiment, the opposing side faces of the one or more arm portions comprise one or more recessed regions to receive and securely engage one or more crimped portions of the opposing sidewalls of the strut

In further preferred embodiments, the body portion comprises one or more apertures extending from the upper face to the lower face.

Preferably, the one or more arm portions comprise one or more apertures extending from the upper face to the lower face and adapted to be aligned with one or more apertures of an engaged strut.

According to a second aspect of the invention there is provided a method of engaging a bracket as defined in any of claims 1 to 21 and a strut, the method comprising the steps of:

mounting the strut on the arm portion by locating the complementary lips of the strut in the grooves of the arm portion;

securing the strut on the arm portion by crimping one or more portions of the strut into one or more recessed regions of the arm portion.

In one embodiment the method further comprises the steps of:

inserting a first portion of the lips into the respective grooves of the strut; and

sliding the lips along the length of the grooves until the strut abuts the body portion and the lips are received and releasably engaged by the grooves.

In another embodiment the method further comprises the steps of:

inserting a first portion of the protruding portions into the respective U-shaped channel portions of the struts; and

sliding the protruding portions along the length of the U-shaped channel portions whilst the lips slide along the length of the grooves until the strut abuts the body portion and the protruding portions are received and releasably engaged by the U-shaped channel portions.

Preferably the method further comprises the step of crimping one or more portions of the strut into one or more recessed regions using a crimping system comprising one or more hydraulic rams having a shaping tool for deforming and thereby securely locating the one or more crimped portions in the one or more recessed regions.

In a further embodiments of this aspect of the invention the method may comprise one or more of the following steps:

crimping one or more portions of the lips of the strut into one or more recessed regions on the protruding portions of the arm portion;

crimping one or more portions of the base of the strut into one or more recessed regions on the upper face of the arm portion;

crimping one or more portions of the base of the strut into one or more recessed regions on the lower face of the arm portion;

crimping one or more portions of the opposing sidewalls of the strut into one or more recessed regions on the opposing side faces of the arm portion;

simultaneously crimping one or more portions of the strut into one or more recessed regions of the side faces of the arm portion.

According to a third aspect of the invention there is provided a method of engaging a bracket as defined in the first aspect of the invention and a plurality of struts, the method comprising repeating any of the method steps of the second aspect of the invention to mount and secure a strut on each arm portion. In a preferred embodiment of this aspect of the invention the method comprises the step of simultaneously crimping one or more portions of the struts into the one or more recessed regions of the each arm portion.

According to a fourth aspect of the invention there is provided a frame comprising a plurality of brackets as defined in the first aspect of the invention and a plurality of engageable struts.

According to a fifth aspect of the invention there is provided a frame comprising a plurality of brackets and engageable struts, the bracket comprising a body portion and

one or more arm portions extending from the body portion, wherein the one or more arm portions include:

at least one pair of parallel grooves adapted to releaseably engage complementary lips of the strut; and

at least one recessed region adapted to securely engage one or more crimped portions of the strut.

A sixth aspect of the invention provides a frame as defined in the fifth aspect of the invention, for supporting building services.

A seventh aspect of the invention provides a method of constructing a frame according to the fifth or sixth aspects of the invention, the method comprising the steps of contemporaneously or sequentially mounting and securing respective struts to arm portions of the brackets to form a frame structure.

Preferably the method comprises repeating any of the method steps of the second aspect of the invention to mount and secure a strut on each arm portion of a bracket.

Preferably the method comprises the step of simultaneously crimping one or more portions of the struts into one or more recessed regions of the arm portions of one or more brackets.

The present invention seeks to overcome the disadvantages of conventional frames as discussed above. Embodiments of the invention seek to provide a frame that can be constructed more quickly, easily, efficiently, accurately and cheaply. The present invention advantageously avoids the use of nuts and bolts. The present invention also advantageously avoids the welding and subsequent galvanising of the frame. As a result, the present invention counteracts the distortion problems and consequentially reduces the reject rate. Embodiments of the present invention also seek to provide a frame that is not restricted to a standard size structure and can be made to order more easily.

Furthermore, embodiments of the present invention seek to provide a frame that is easier to store and/or transport because it does not comprise any protruding portions that extend beyond the main body of the frame.

BRIEF DESCRIPTION OF DRAWINGS

For a better understanding of the invention and to show how it may be carried into effect, reference shall now be made by way of example to the accompanying drawings, in which:

Figure 1 depicts a conventional strut having a generally U-shaped cross-sectional profile;

Figure 2 depicts a conventional strut having a generally C-shaped cross-sectional profile;

Figure 3A depicts a plan view of a first embodiment of a bracket according to the invention;

Figure 3B depicts a cross-sectional view of an arm portion of the first embodiment of the bracket;

Figure 4 depicts a perspective view of the first embodiment of the bracket;

Figure 5 depicts a perspective view of struts mounted on the first embodiment of the bracket;

Figure 6A depicts a perspective view of a second embodiment of a bracket according to the invention;

Figure 6B depicts a cross-sectional view of an arm portion of the second embodiment of the bracket;

Figure 6C depicts a cross-sectional view of an alternative version of an arm portion of the second embodiment of the bracket;

Figure 6D depicts a cross-sectional view of a further alternative version of an arm portion of the second embodiment of the bracket;

Figure 7 depicts a perspective view of a third embodiment of a bracket according to the invention;

Figure 8 depicts a perspective view of a fourth embodiment of a bracket according to the invention;

Figure 9A depicts a perspective view of a fifth embodiment of a bracket according to the invention;

Figure 9B depicts plan views of struts having an aperture mounted on the fifth embodiment of the bracket;

Figure 10A, 10B, 10C and 10D depict plan views of struts mounted on brackets to form a two-dimensional frame.

DETAILED DESCRIPTION OF INVENTION

A bracket according to the invention comprises a body portion and at least one arm portion. The bracket is configured such that a strut may be mounted on and secured to each of the arm portions. A frame may be constructed by engaging a plurality of brackets and struts to form a two-dimensional or three-dimensional frame-like structure.

Figures 3A and 4 depict an embodiment of a bracket (1) according to the invention comprising a body portion (2) and two arm portions (3). The body portion (2) includes an upper face (4), lower face (5) and four side faces (6a, 6b, 6c, 6d). The faces of the body portion in Figures 3A and 4 are approximately equal in size such that the body portion has a generally cuboid shape. Alternatively, two opposing side faces may be longer than the other two opposing side faces such that the body portion may be elongate having a parallelepiped shape.

The upper face and/or lower faces of the body portion may comprise a recessed region to reduce the overall weight of the bracket. Both the upper face (4) and lower face (5) of the body portion depicted in Figures 3A and 4 comprise a recessed region (7).

The body portion may comprise one or more apertures. In the embodiment depicted in Figures 3A and 4, a single aperture (8) extends through the body portion from the recessed region (7) of the upper face (4) to the recessed region (7) of the lower face (5). The one or more apertures may be configured to receive pipes, cables etc. The apertures may be shaped and arranged to receive interconnecting means e.g. a rod, to

connect the bracket to another bracket in order to interconnect another frame structure. The one or more apertures may also or alternatively receive interconnecting means to interconnect the bracket to a supporting surface e.g. a wall, ceiling and/or floor such that the frame is supported. Furthermore, the apertures may additionally or optionally receive interconnecting means to store and/or transport a plurality of brackets and possibly the frames of which the brackets are a part.

The arm portions (3) of the bracket in Figures 3A and 4 include an upper face (9), lower face (10), opposing end faces (11a, 11c) and opposing side faces (11b, 11d)). The arm portions (3) may be generally cuboid in shape, having faces that are substantially the same size. Or the arm portions (3) may be parallelepiped in shape, having longer side faces (11b, 11d) than end faces (11a, 11c) as shown in Figure 3A and 4.

The arm portions may extend generally perpendicularly from one or more side face of the body. For example, the bracket may comprise a body portion and only one arm portion extending perpendicularly from a side face of the body portion. In Figure 7 two arm portions extend perpendicularly from opposing side faces of the body portion to form a substantially I-shaped bracket. Figures 3A and 4 depict a generally L-shaped bracket in which two arm portions extend perpendicularly from adjacent side faces of the body portion. Such brackets may be used to form the corner of a 2-dimensional frame. In Figure 6A, three arm portions extend perpendicularly from three side faces of the body portion to form a substantially T-shaped bracket. Figure 8 depicts a cross-shaped bracket in which four arm portions extend perpendicularly from the each side face in a horizontal plane. The I-shaped, T-shaped and cross-shaped brackets may be used as intermediary brackets within a frame structure.

The arm portions may optionally or additionally extend generally perpendicularly from the upper face and/or lower face of the body portion. For example, a corner bracket for a three-dimensional frame may comprise two arm portions extending perpendicularly in a horizontal plane from adjacent side faces of the body and a further arm portion extending substantially perpendicularly in a vertical plane from the upper face of the body. A further embodiment of a bracket may comprise arm portions extending substantially perpendicularly in a horizontal plane from each side face and substantially perpendicularly in a vertical plane from the both the upper and lower faces of the body portion.

When an arm portion extends perpendicularly from the upper and/or lower face of the body portion, both the arm portion and mounted strut are configured such that the aperture extending through the body portion is accessible and able to receive the requisite pipes, cables etc and/or interconnecting means.

It can be clearly seen in Figures 3A and 4 that the arm portions are shaped and sized such that its cross-sectional dimensions are slightly smaller than those of the side faces of the body. The arm portions as so configured such that, when a strut is mounted on the arm portion, the strut is generally flush with the side face of the body as shown in Figure 5.

The bracket may be formed from any suitable material, such as plastic, metal etc. However, a bracket used in a frame for supporting building services is preferably formed from iron with a zinc coating. The bracket may be integrally formed using a casting or moulding process. Alternatively, the body portion and arms portions may be formed separately and subsequently connected together using conventional attaching means.

The arm portions of a bracket comprise at least one pair of parallel grooves to engage the lips (C) of a strut. The parallel grooves may extend longitudinally along the upper face and/or the lower face of the arm portions. The grooves preferably extend along the entire length or a substantial part of the upper and/or lower faces. The grooves may be arranged to define protruding portions to further engage the struts. For example, the grooves may be arranged such that they define two edge protrusions and a central portion on the upper and/or lower face of the arm portions. The arm portions of the bracket depicted in Figures 3A and 4 comprise a pair of grooves (12) that extend a spaced distance apart along the entire length of the upper face (9). The grooves are located adjacent the edges of the upper face such that they define a first edge protrusion (13a), second edge protrusion (13b) and a central protrusion (14). These features are also depicted in the cross-sectional profile of the arm portion shown in Figure 3B along line AA.

The grooves formed on the upper face (9) and/or lower face (10) are shaped and arranged to receive and mate with the lips (C) of a U-shaped strut as depicted in Figure 1. The lips and grooves do not interlock, but releaseably engage, when the lips are inserted in the grooves. Hence, the lips are free to slide along the grooves and be removed from the grooves as and when required. The edge protrusions (13a, 13b) of the

upper and/or lower faces are configured to be received by and mate with the complementary U-shaped channel portions (D) of the U-shaped strut. As with the lips and grooves, the edge protrusions and U-shaped channel portions releaseably engage rather than interlock. Thus, a U-shaped strut may be mounted on an arm portion by inserting the lips into the grooves, locating the edge protrusions in the U-shaped channel portions and sliding the strut along the arm portion (by sliding the lips along the length of the grooves) until it abuts the side face of the body portion, as shown in Figure 5. Figure 5 also shows how a mounted strut envelops the side faces (11a, 11d) and lower face (10) of an arm portion if the grooves (12) are arranged on the upper surface (9) of the arm portion. It is therefore evident that a strut will envelop the side faces (11b, 11d) and upper face (9) of the arm portions if grooves are arranged on the lower face (10) of the arm portion. The bracket may be configured such that it is suitable for engaging conventional U-shaped channel members of a range of different sizes. If the brackets and struts are to be used in a frame for supporting building services, then the struts preferably have a width of 41mm and depth of either 21mm or 41mm. Depending on the size of the strut and the arrangement of the grooves, the base (A) of a strut and upper face (9) or lower face (10) of an arm portion may be adjacent or in surface-to-surface contact.

The arms portions may additionally or alternatively comprise a pair of grooves extending longitudinally, in parallel alignment, along opposing side faces of the arm portion as shown in Figures 6A, 6B, 6C and 6D. The grooves may extend substantially or entirely along the length of the side faces. The grooves may, but need not, be arranged centrally on the side faces of the arm portion. The grooves may define protruding portions to further engage the strut. For example, the grooves along the side faces may each define one or two edge protrusions. In the embodiment depicted in Figure 6A, the grooves (12) are arranged centrally on the side faces (11b, 11d), extend longitudinally in parallel alignment with respect to one another and each define a first edge protrusion (13c) and a second edge protrusion (13d). In this particular embodiment, since a pair of grooves also extend along the upper surface of the arm portion, the first edge protrusions (13c) on the side faces are the same as the first and second edge protrusions (13a, 13b) on the upper face.

The grooves formed on the opposing side faces may be configured as shown in the cross-sectional profile of Figure 6B such that they receive and releaseably engage the lips (C') of a C-shaped strut (see Figure 2). Likewise, the first and second edge

protrusions are shaped and arranged such they releaseably mate with the complementary U-shaped channel portions (D') of the C-shaped strut. Hence, a C-shaped channel member may be mounted on an arm portion by inserting the lips in the grooves, locating the edge protrusions in the U-shaped channel portions and sliding the strut along the arm portion (by sliding the lips along the length of the grooves) until it abuts the side face of the body portion. A C-shaped channel member may be mounted on an arm portion such that it envelops the upper section of the side faces and upper face of the arm portion, or it envelops the lower section of the side faces and lower face of the arm portion. The bracket may be configured to engage with any conventionally sized C-shaped strut. However, the width of the strut is preferably 41mm if it is to be used as part of a frame to support building services. Hence, depending on the size and mounting arrangement of the strut, the base (A') of the C-shaped channel member may be arranged adjacent or in surface-to-surface contact with the lower face or upper face of the arm portion.

The grooves formed on the opposing side faces of the arm portion may be alternatively configured as shown in the cross-sectional profile of Figure 6C or 6D such that they receive and releaseably mate with the lips (C) of the U-shaped strut (see Figure 1). Furthermore, the first and second edge protrusions are shaped and arranged to releaseably mate with the U-shaped channel portions (D) of the U-shaped strut. The grooves are configured in the embodiment of the bracket depicted in Figure 6C such that a mounted strut envelops the lower section of the side faces and lower face of the arm portion. Whereas the grooves are configured in the bracket of Figure 6D such that a mounted strut envelops the upper section of the side faces and upper face of the arm portion. Again, the bracket may be configured such that it is suitable for engaging with any conventionally sized U-shaped channel member. Furthermore, depending on the configuration of the grooves and the size of the strut, the base (A) of the strut may be arranged adjacent or in surface-to-surface contact with the upper or lower face of the arm portion.

The arm portions may further comprise one or more apertures (18) extending from the upper face (9) to the lower face (10) as depicted in Figure 9A. The openings of the apertures may be formed in the central portions and/or recessed regions of the arm portions. The base of the strut (A, A') may also comprise one or more apertures (18'). The apertures may be formed centrally in the base of the strut. An aperture may be formed a spaced distance from the abutting edge of the strut or it may extend from the

abutting edge of the strut as shown in Figure 9B. The apertures of both the arm portions and struts are configured such that they are substantially aligned, forming one or more through paths, when a strut is mounted and secured on an arm portion. The resulting one or more apertures extending through both the strut and arm portion are configured to receive interconnecting means to interconnect other frame parts and/or interconnecting means to interconnect the frame to a supporting surface. The apertures may also or alternatively be configured to receive cables and/or pipes.

The arm portions further comprise one or more recessed regions to receive and permanently engage one or more crimped portions the strut. The recessed region may comprise a notch (15) or cavity space (16) arranged on an edge protrusion to receive and clamp a crimped portion of the lip of the strut. A plurality of notches and/or cavity spaces are preferably arranged at spaced distances along one or more of the edge protrusions. When the grooves extend longitudinally along the upper and/or lower face, the notches and/or cavity spaces on the first edge protrusion (13a) are preferably arranged substantially opposite the notches and/or cavity spaces on the second edge protrusion (13b) as seen in Figures 3A and 4. When the grooves are arranged to extend longitudinally along the side faces of the arm portion, the notches and/or cavity spaces may be arranged a spaced distance apart on the first edge protrusion substantially opposite the notches and/or cavity spaces on the second edge protrusion on the same side face. The notches and/or cavity spaces may additionally or alternatively be located opposite the notches and/or cavity spaces on the equivalent edge protrusion of the other side face. Figure 6A depicts an embodiment of a bracket where a pair of grooves (12) extend along the upper surface (9) of the arm portion and two sets of notches (15) are arranged in spaced relationship along the first and second edge protrusions (13a, 13b) of the upper face. A further pair of grooves (12) extend along the side faces (11b, 11c) of the arm portion and a cavity space (16) is formed in each of the second edge protrusions (13d).

The upper face and/or lower face of the arm portions may additionally or alternatively comprise one or more recessed regions to receive and securely engage one or more crimped portions of the base of a strut. Figure 4 depicts a bracket wherein the lower face of the arm portion comprises a cavity space (17) to receive and engage a crimped portion of the base of the strut. The recessed regions are preferably arranged centrally on the upper and/or lower faces. Depending on the arrangement of the grooves, the recessed region may be located in the central portion of the upper and/or lower faces.

One or more of the side faces of the arm portion may optionally or additionally comprise one or more recessed regions to receive and retain one or more crimped portions of the sidewalls of a strut.

A strut is crimped by applying a force to deform one or more portions of the strut such that the crimped portions are inserted into and retained within the one or more corresponding recessed regions. Crimping effectively mechanically connects or interlocks the strut and arm portion.

A strut may be crimped by applying a force on the lips of the strut such that one or more crimped portions of the lip are located and locked within the notches and/or cavity spaces on the edge protrusions of the upper or lower surface of the arm portion. In order to securely engage the strut it is preferable for both lips to be crimped.

A strut may be crimped by applying a force on the base of the strut such that one or more crimped portions of the base are received and securely engaged by the one or more recessed regions on the upper or lower surface of the arm portion.

Likewise, a strut may be crimped by applying a force to the sidewalls of the strut such that one or more crimped portions of the sidewalls are positioned and clamped within the one or more recessed regions on the side faces of the arm portion. The strut is more securely engaged if both sidewalls are crimped.

A strut may be crimped using a crimping system comprising one or more hydraulic rams to apply a deforming pressure. The strut is crimped by lowering the hydraulic ram into position such that a shaped tool acts on the requisite parts of the strut such that portions are deformed and securely located within the corresponding recessed regions. The crimping system may simultaneously or sequentially crimp one or more parts of a strut. For example, both the lips and base of a strut may be simultaneously crimped by a hydraulic ram. The crimping system may be adapted to simultaneously or sequentially crimp two or more struts mounted on two or more arm portions of a bracket. Furthermore, the crimping system may be adapted to simultaneously or sequentially crimp one or more struts on the arm portions of two or more brackets. For example, the crimping system may simultaneously crimp both ends of a strut such that each end of the strut is simultaneously secured to an arm portion of different brackets. The crimping

system may also comprise support means to support the struts and/or brackets of a frame structure whilst one or more struts are being crimped by the hydraulic rams.

The brackets and one or more struts must be sufficiently engaged such that they can withstand the weight of objects supported by the struts. For example, the brackets and struts must be sufficiently engaged such that they can be used as part of a frame to support building services. It has been found that a force equating to the weight of over 828kg is required to separate U-shaped strut that has been secured to an arm portion, having two parallel grooves along its upper surface, by crimping the base of the strut and two portions of each lip. Thus, such an arrangement is well able to support pipes, cables and the like.

A plurality of brackets and struts may be used to form a frame. The brackets and struts may be used to form a two-dimensional or three-dimensional frame structure. The two-dimensional frame may be any two-dimensional shape such as a square, rectangle, circle, triangle etc. Likewise, the three-dimensional frame may be any three-dimensional shape such as a cube, parallelepiped rectangle, cylinder, pyramid etc.

The frames are formed by mounting struts on the arms of the brackets to form the requisite frame shape and systematically crimping the struts to secure them to the brackets. It will be appreciated by those skilled in the art that the mounting and securing steps may be carried out in any suitable order.

It will also be appreciated that the frames may be interconnected using interconnecting means extending through the one or more apertures of the bracket.

One particular method of forming of a two-dimensional rectangular frame shall now be described with respect to Figures 10A, 10B, 10C and 10D. The frame comprises four L-shaped corner brackets (B1, B2, B5 & B6), two T-shaped intermediary brackets (B3, B4), three cross-rail struts (S1, S2, S3) and four side-rail struts (S4, S5, S6 & S7). The struts are cut to size such that the frame has an overall length of 1041mm and overall width of 382mm.

A first pre-cut strut (S1) is mounted on two L-shaped brackets by sliding the first end of the strut (S11) on the first arm portion of the first bracket (AP1B1) and sliding the second end of the strut (S12) on the first arm portion of the second bracket (AP1B2) as depicted

in Figure 10A.

A second pre-cut strut (S2) is mounted on two T-shaped brackets by sliding the first end of the strut (S21) on the first arm portion of the third bracket (AP1B3) and sliding the second end of the strut (S22) on the first arm portion of the fourth bracket (AP1B4) as depicted in Figure 10B.

A third pre-cut strut (S3) is mounted on two further L-shaped brackets by sliding the first end of the strut (S31) on the first arm portion of the fifth bracket (AP1B5) and sliding the second end of the strut (S32) on the first arm portion of the sixth bracket (AP1B6) as depicted in Figure 10C

A fourth pre-cut strut (S4) is mounted on the first bracket (B1) by sliding the first end of the strut (S41) on the second arm portion of the first bracket (AP2B1) and a fifth pre-cut strut (S5) is mounted on the second bracket (B2) by sliding the first end of the strut (S51) on the second arm portion of the second bracket (AP2B2) as depicted in Figure 10A

The first and second brackets (B1, B2) are located in the crimping system such that the first end of the first strut (S11) and the first end of the fourth strut (S41) are simultaneously crimped onto the first bracket (B1) whilst the second end of the first strut (S12) and the first end of the fifth strut (S51) are simultaneously crimped on to the second bracket (B2) using two hydraulic rams.

The fourth strut (S4) is mounted on the third bracket (B3) by sliding the second end of the strut (S42) on the second arm portion of the third bracket (AP2B3) and the fifth strut (S5) is mounted on the fourth bracket (B4) by sliding the second end of the strut (S52) on the second arm of the fifth bracket (AP2B5) as depicted in Figure 10B.

A sixth strut (S6) is mounted on the third bracket (B3) by sliding the first end of the strut (S61) on the third arm portion of the third bracket (AP3B3) and a seventh strut (S7) is mounted on the fourth bracket (B4) by sliding the first end of the strut (S71) on the third arm portion of the fourth bracket (AP3B4) as depicted in Figure 10B.

The third and fourth brackets (B3, B4) are located in the crimping system such that the second end of the fourth strut (S42), the first end of the second strut (S21) and first end

of the sixth strut (S61) are simultaneously crimped to the third bracket (B3) whilst the second end of the fifth strut (S52), the second end of the second strut (S22) and the first end of the seventh strut (S71) are simultaneously crimped on the fourth bracket (B4).

The sixth strut (S6) is mounted on the fifth bracket (B5) by sliding the second end of the strut (S62) on the second arm portion of the fifth bracket (AP2B5) and the seventh strut (S7) is mounted on the sixth bracket (B6) by sliding the second end of the strut (S72) on the second arm portion of the sixth bracket (AP2B6) as depicted in Figure 10C

The fifth and sixth brackets (B5, B6) are located in the crimping system such that the first end of the third strut (S31) and second end of the sixth strut (S62) are simultaneously crimped on to the fifth bracket (B5) whilst the second end of the third strut (S32) and second end of the seventh strut (S72) are simultaneously crimped on to the sixth bracket (B6).

Thus, a two-dimensional frame is formed as depicted in Figure 10D

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", means "including but not limited to", and is not intended to (and does not) exclude other moieties, additives, components, integers or steps.

Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith.